G 29/4

NEWARK PUBLIC LIBRARY

NOV 1 1985

U. S. GOVT. PUBS.
DEPOSITORY 325

Earth's Heat

Geothermal Energy on the National Forests of the Pacific Northwest

READEX FICHE

United States Department of Agriculture

Forest Service Pacific Northwest Region

A13.2:

Introduction

Currently, production of energy in the world is associated with a number of problems. Some of these concerns are the stability of the world oil market, acid rain, degradation of fish habitat, the effects of coal strip mining, air pollution, and nuclear wastes. In the United States, alternative forms of energy are being explored and evaluated. These alternatives include wind, low head hydroelectric, solar resources, and tapping heat from within the earth.

Tapping heat from within the earth (geothermal energy) is not yet intensively developed, or widely used, however it may offer environmental advantages over existing energy-producing techniques. The potential for finding sites where useable geothermal energy can be produced appears high in both Oregon and Washington.

What is Geothermal Energy?

Geothermal energy comes from heat in the interior of the earth, as the root words of the name suggest: geo = earth; thermal = heat. Everywhere on earth, temperature increases with depth under the ground. Far down in the earth's core, in fact, the temperature is white hot. Most of this immense heat is of ancient origin. Closer to "home", near the earth's surface, this heat energy influences hot springs, volcanos, and the movement of continents. It also plays a role in the formation of precious metals.

Drawing from artist's sketch provided by Union Oil Co.

Magma, the molten rock found deep within the earth, radiates heat energy into underground water. This heated water (or steam in some cases) can be tapped to produce power, heat buildings or use in manufacturing processes.

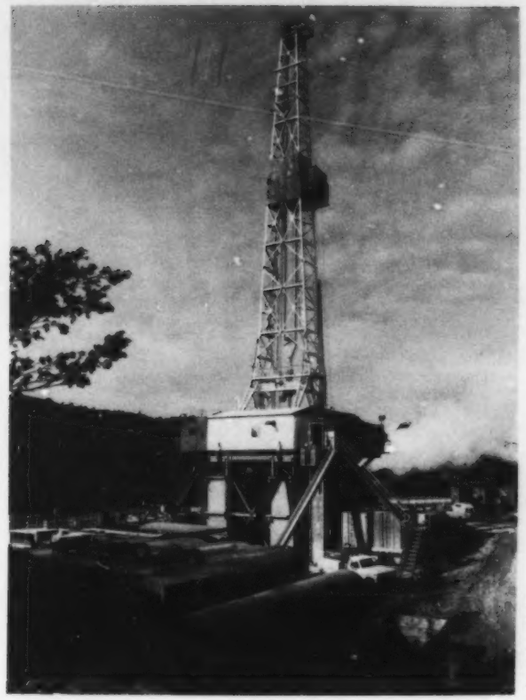


Photo by Union Oil Co.

Specially-equipped rotary drilling rigs are used to drill geothermal wells.

Water is the natural carrier of geothermal energy. Fractures and faults in the rocks of the earth's crust provide pathways for surface water to descend and mingle with hot or molten rock. Once heated, the resulting hot water or steam rises along other fractures and collects in reservoirs of porous rock usually capped by an impervious layer of rock. These reservoirs can be reached by drilling. Sometimes, the water or steam may migrate all the way to the surface, forming a natural hot spring or fumerole. Underground or at the surface, geothermal fluids may contain many dissolved gases and minerals picked up along the way. Consequently, some may actually be many times saltier than the oceans.

Another method used to collect geothermal heat involves drilling directly into molten rock. In this case, water to be heated is circulated in and out of a single hole. The procedure has been used successfully in Hawaii. Indications are that this technique – although only in the experimental stage – could provide us with vast amounts of energy, if the method proves economical.

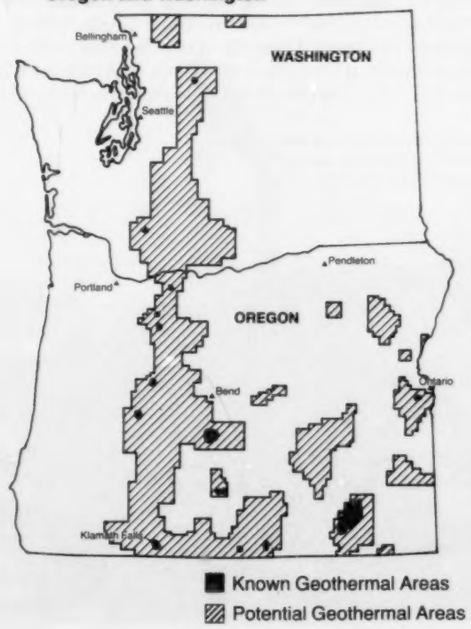
Theoretically, geothermal energy can be extracted from hot, dry rock. Cold water would be pumped into the hot rock (via a well) and forced into fractures, artificially induced through wells or explosions. Contact with the rock would heat the water, which would then be withdrawn from a second well.

Where Is It Found?

Only certain places in the world offer favorable conditions for the development of geothermal energy. These are usually volcanic regions such as Japan and Hawaii; or highly fractured regions where the earth's crust is thin, such as Nevada.

In the Pacific Northwest, the volcanos of the Cascade Range and the fractured and faulted land of southeast Oregon appear to hold high geothermal potential.

Known and potential geothermal areas in Oregon and Washington



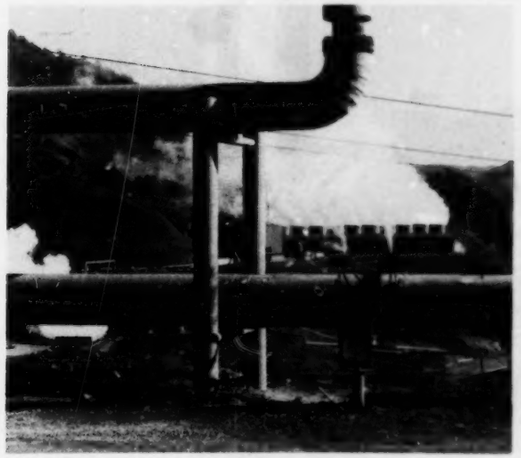
Why On National Forests?

The Geothermal Steam Act of 1970 and the Nation's energy policy have thrust the U.S. Department of Agriculture's Forest Service into the geothermal energy field. Since the early 1970's, all departments of the Federal government are required to actively assist in gaining energy independence for America. The Forest Service is especially involved because much of the potentially available geothermal energy in the Pacific Northwest is located beneath the National Forests.

National Forests in the Pacific Northwest are managed for a variety of uses including timber, recreation, scenery, and water. Geothermal energy development is one of these uses, though a new one. In theory, the heat energy under the land surface of the United States could supply all the Nation's energy needs.

Since the passage of the Geothermal Steam Act of 1970 by Congress, National Forest managers have systematically inventoried land to determine which areas could be available for geothermal leasing and development. After a careful analysis of environmental factors and existing uses, this decision is made, and the Bureau of Land Management is informed which lands should be available for long-term leasing. The Bureau is involved because Congress has made them responsible for managing the minerals, oil and gas and geothermal resources beneath the Earth's surface. Of course, some areas – such as designated Wilderness, Wild and Scenic Rivers, and National Recreation Areas – are not eligible for leasing, as they are already closed to this type of development by law.

Insulated pipelines transport geothermal steam or fluids from producing wells to electrical generating plants at The Geysers, a geothermal project in California.



Geothermal Uses

Roman documents 2,000 years old tell of a steam field at what is now Larderello, Italy, west of Florence. In 1904, an electric power plant utilizing natural steam was operated there experimentally – the first of its kind in the world. Today, natural steam power plants at Larderello produce 170 megawatts of electricity. Currently, the world's largest developed geothermal field is The Geysers, about 70 miles north of San Francisco. Here, 1,600 megawatts are generated, and development for nearly 1,000 additional megawatts is planned. By comparison, the Trojan Nuclear Plant (north of Portland, Oregon) produces 1,100 megawatts, which can supply the needs of a city of 1.1 million people.

In 1985, worldwide production of electricity using geothermal resources was 5,800 megawatts. Leading producers of geothermal power are the United States, the Philippines, Italy, Mexico, Japan, and New Zealand. Altogether, sixteen countries currently generate electricity with geothermal steam or hot water.

Direct use of geothermal energy has been small scale in the past: mostly bathing, cooking and heating. In direct use

Greenhouses can be heated with geothermal energy.

the warm or hot water is piped into homes or businesses. Today, however, many large-scale projects have been developed for district heating, warming greenhouse complexes, and industrial processing of foodstuffs. Altogether, about 2,000 megawatts of geothermal energy (non-electric) are used in direct applications worldwide – mainly in Iceland, New Zealand, the USSR, Japan, and Hungary. In the Pacific Northwest, homes, schools, and business districts in Boise, Idaho and Klamath Falls, Oregon are heated directly by warm water pumped from wells.

Photo by Geothermal Resources Council

In Brady, Nevada, vegetables are dried using geothermal heat.

Photo by Geothermal Resources Council

Prawns are grown using geothermally heated water in Klamath Falls, Oregon.

Environmental Concerns

Geothermal developments alter the environment to varying degrees. To understand and respond to changes brought about by geothermal developments, information about air and water quality, ecological systems, noise, seismicity (earthquakes), and land subsidence (sinking) must be collected before plans for developments can be finalized.

Geothermal fluids contain a variety of gases, some of which can be harmful or distasteful if released to the atmosphere. Hydrogen sulfide smells obnoxious to most people. Geothermal fluids contain and release this gas in various amounts. Fortunately, emissions can be reduced to safe levels. New technologies are expected to reduce emissions even further.

Surface and ground water can be contaminated by toxic compounds such as boron, arsenic, and mercury, which are sometimes found in geothermal fluids. To prevent contamination, test and production holes must be lined with steel and concrete so that no fluids leak into the ground water. Temporary reservoirs that hold geothermal fluids during testing must be lined with plastic or clay. Waste fluids produced during power generation

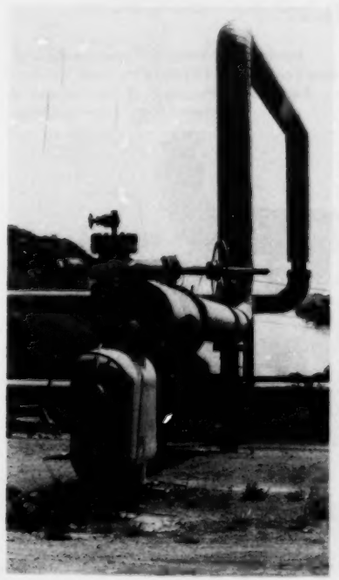


Photo by Geothermal Resources Council

Valves control the flow of geothermal fluids and provide additional environmental protection.

may be reinjected or evaporated in lined ponds. Properly designed, constructed, and monitored, a geothermal development can have little or no effect on local water quality. However, it is possible for accidents such as a blow out (an uncontrolled flowing well), a broken pipeline, or a leaky reservoir to harm the environment.

Modern geothermal developments seem to affect local plants and animals only to the extent that their habitat has been altered at well pads, roads, power plants, and other disturbed areas. However, not enough time has gone by to confirm this observation. These disturbed areas usually amount to five to 20 percent of the total development area.

During construction and operation of geothermal developments, noise levels can be quite high. Well-drilling rigs and earthmoving equipment can of course be quite noisy – as can producing wells, blowing wells (which may be temporarily opened to the atmosphere to clean out), and cooling towers. Sophisticated mufflers can reduce levels to more acceptable levels.

Withdrawal of geothermal fluids can cause small earthquakes but few have ever been reported. At the same time, the land may sink slightly. In large flat areas, sinking could alter the course of rivers, cause ponds to form, or damage structures. Reinjection of fluids may reduce these effects, if they occur at all. In rugged areas such as the Cascades, the effects of sinking may be negligible.

Insulated pipelines can often be located to blend with the surrounding terrain between the wellhead and the point of use.

Photo by Geothermal Resources Council

Photo by Geothermal Resources Council

Multiple wells can be directionally drilled from a single well pad, thereby reducing the area disturbed.

The Future

Current technological and economic factors do not permit geothermal power systems to be developed everywhere, and at this time it is impossible to predict geothermal power's long-range contribution to America's total energy supply. However, it is presently a welcome supplement to traditional energy sources.

Several hundred thousand acres of National Forest land have been leased for geothermal exploration and development in Oregon and Washington. Leaseholders include individuals, energy companies, and other private interests. Lease receipts are split between Federal, State and local governments. Leasing is a commitment to develop the resource if environmental impacts can be minimized. Leaseholders must submit exploration and development plans (before any drilling or development) to the Bureau of Land Management of the US Department of the Interior. These plans must be specific, discussing the proposed project's size and its impacts. In some cases the analysis may be quite simple. Plans involving plant development, however, may be quite complex, and require extensive public involvement and completion of an Environmental Impact Statement (as required by the National Environmental Policy Act).

In Oregon and Washington, the most promising areas for geothermal development occurring on lands managed by the USDA Forest Service are found on the Deschutes, Fremont, Mt. Baker-Snoqualmie, Mt. Hood, Willamette and Winema National Forests.

For More Information

Although geothermal energy production is a relatively new field, a large amount of information is available already. If you would like more information, you can contact the agencies listed below:

- USDA, Forest Service
  Pacific Northwest Region
  P.O. Box 3623
  Portland, OR 97208
- USDI, Bureau of Land Management
  State Office
  P.O. Box 2965
  Portland, OR 97208
- or any local National Forest or
  Bureau of Land Management office.

U.S. GOVERNMENT PRINTING OFFICE: 1985—593-027/21004 REGION NO. 8